



CHEMISTRY
HIGHER LEVEL
PAPER 1

Tuesday 16 May 2000 (afternoon)

1 hour

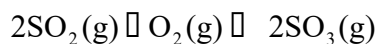
INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.

Periodic Table

		Atomic Number																2 He 4.00																	
1 H 1.01																																			
3 Li 6.94		4 Be 9.01																		9 F 19.00															
11 Na 22.99		12 Mg 24.31																		17 Cl 35.45															
19 K 39.10		20 Ca 40.08		21 Sc 44.96		22 Ti 47.90		23 V 50.94		24 Cr 52.00		25 Mn 54.94		26 Fe 55.85		27 Co 58.93		28 Ni 58.71		29 Cu 63.55		30 Zn 65.37		31 Ga 69.72		32 Ge 72.59		33 As 74.92		34 Se 78.96		35 Br 79.90		36 Kr 83.80	
37 Rb 85.47		38 Sr 87.62		39 Y 88.91		40 Zr 91.22		41 Nb 92.91		42 Mo 95.94		43 Tc 98.91		44 Ru 101.07		45 Rh 102.91		46 Pd 106.42		47 Ag 107.87		48 Cd 112.40		49 In 114.82		50 Sn 118.69		51 Sb 121.75		52 Te 127.60		53 I 126.90		54 Xe 131.30	
55 Cs 132.91		56 Ba 137.34		57 † La 138.91		72 Hf 178.49		73 Ta 180.95		74 W 183.85		75 Re 186.21		76 Os 190.21		77 Ir 192.22		78 Pt 195.09		79 Au 196.97		80 Hg 200.59		81 Tl 204.37		82 Pb 207.19		83 Bi 208.98		84 Po (210)		85 At (210)		86 Rn (222)	
87 Fr (223)		88 Ra (226)		89 ‡ Ac (227)		104 Rf (261)		105 Db (262)		106 Sg (263)		107 Bh (262)		108 Hs (262)		109 Mt (262)																			

1. According to the equation:



what volume of air (20 % O_2) is required to react with 10 dm^3 of SO_2 ?

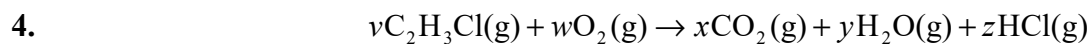
- A. 2 dm^3
 - B. 5 dm^3
 - C. 10 dm^3
 - D. 25 dm^3
2. Which of the following compounds has the greatest **empirical** formula mass?

- A. C_6H_6
- B. C_4H_{10}
- C. C_3H_6
- D. C_2H_6

3.
$$\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$$

When heated, CaCO_3 ($M_r = 100$) decomposes as shown above. When 20 g of impure CaCO_3 is heated, 0.15 moles of CO_2 are obtained. What is the percentage purity of the CaCO_3 ? (Assume that none of the impurities produce CO_2 upon heating.)

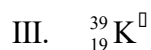
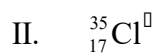
- A. 15
- B. 25
- C. 55
- D. 75



Chloroethene can be burned in oxygen as shown above. What is the value of w when $v = 2$?

- A. 2
- B. 3
- C. 4
- D. 5

5. Which of the following particles contain more electrons than **neutrons**?

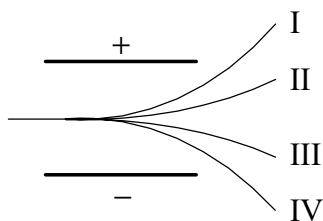


- A. I only
- B. II only
- C. I and II only
- D. II and III only

6. The first four ionisation energies (kJ mol^{-1}) for a particular element are 550, 1064, 4210 and 5500 respectively. This element should be placed in the same Group as

- A. Li
- B. Be
- C. B
- D. C

7. A certain element with two isotopes of masses M and $M + 2$ is introduced into a mass spectrometer, vaporised and ionised. Which of the following paths are most likely for the resulting ions?



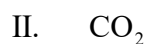
- | | M | $M + 2$ |
|----|-----|---------|
| A. | I | IV |
| B. | II | I |
| C. | IV | III |
| D. | IV | II |
8. A certain element has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$. Which oxidation state(s) would this element most likely show?
- A. +2 only
- B. +3 only
- C. +2 and +5 only
- D. +2, +3, +4, +5
9. Which one of the following increases in value from Li to Cs?
- A. Atomic radius
- B. Electronegativity
- C. Ionisation energy
- D. Melting point

10. Which of the following chlorides give neutral solutions when added to water?



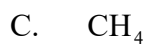
- A. I only
- B. I and II only
- C. II and III only
- D. I, II and III

11. In which of the following is there at least one double bond?



- A. I only
- B. III only
- C. II and III only
- D. I, II and III

12. According to VSEPR theory, which molecule would be expected to have the **smallest** bond angle?



13. Which of the following can exist in **both** polar and non-polar forms?

- A. CH_2Cl_2
- B. C_2HCl
- C. $\text{C}_2\text{H}_2\text{Cl}_2$
- D. $\text{C}_2\text{H}_3\text{Cl}$

14. What are the states of hybridisation for the carbon atoms in NCCH_2COOH ?

- | | CN | CH_2 | COOH |
|----|---------------|---------------|---------------|
| A. | sp | sp^3 | sp^2 |
| B. | sp | sp^2 | sp^3 |
| C. | sp^2 | sp^2 | sp^3 |
| D. | sp^2 | sp^3 | sp^2 |

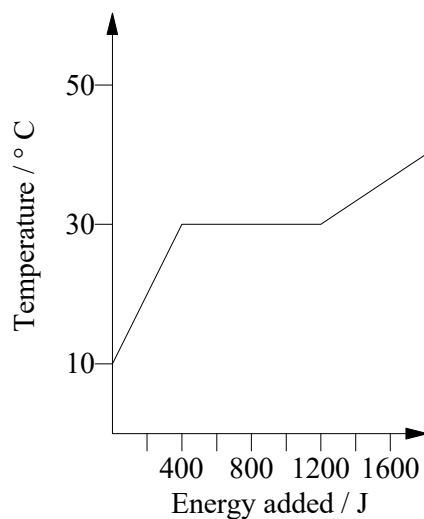
15. Which of the following best accounts for the observation that gases are easily compressed?

- A. Gas molecules have negligible attractive forces for one another.
- B. The volume occupied by the gas is much greater than that occupied by the molecules.
- C. The average energy of the molecules in a gas is proportional to the absolute temperature of the gas.
- D. The collisions between gas molecules are elastic.

16. Which expression represents the density of a gas sample of relative molar mass, M_r , at temperature, T , and pressure, P ?

- A. $\frac{PM_r}{T}$
- B. $\frac{RT}{PM_r}$
- C. $\frac{PM_r}{RT}$
- D. $\frac{RM_r}{PT}$

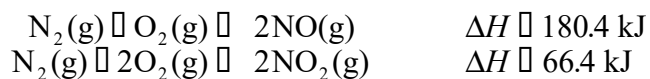
17.



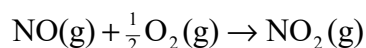
The heating curve for 10 g of a substance is given above. How much energy would be required to melt completely 20 g of the substance that is initially at 10° C?

- A. 2400 J
- B. 1200 J
- C. 800 J
- D. 400 J

18.

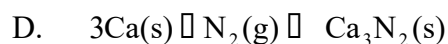
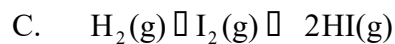
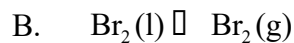
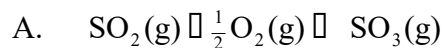


Use the enthalpy values above to calculate ΔH for the reaction;

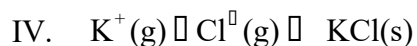
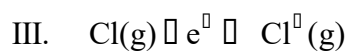
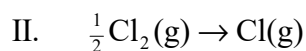
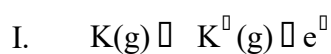


- A. –57 kJ
- B. –114 kJ
- C. 57 kJ
- D. 114 kJ

19. In which reaction is the change in entropy (ΔS) closest to zero?



20. The Born–Haber cycle for the formation of potassium chloride includes the steps below:



Which of these steps are exothermic?

A. I and II only

B. III and IV only

C. I, II and III only

D. I, III and IV only

21. Some collisions between reactant molecules do not form products. This is most likely because

A. the molecules do not collide in the proper ratio.

B. the molecules do not have enough energy.

C. the concentration is too low.

D. the reaction is at equilibrium.

22. Doubling which one of the following will double the rate of a first order reaction?

- A. Concentration of the reactant
- B. Size of solid particles
- C. Volume of solution in which the reaction is carried out
- D. Activation energy

23.
$$\text{F}_2(\text{g}) + 2\text{ClO}_2(\text{g}) \rightarrow 2\text{FClO}_2(\text{g})$$

The following data were obtained for the reaction above. Use these data to determine the orders for the reactants F_2 and ClO_2 .

$[\text{F}_2(\text{g})] / \text{mol dm}^{-3}$	$[\text{ClO}_2(\text{g})] / \text{mol dm}^{-3}$	Rate / $\text{mol dm}^{-3} \text{s}^{-1}$
0.1	0.01	1.2×10^{-3}
0.1	0.04	4.8×10^{-3}
0.2	0.01	2.4×10^{-3}

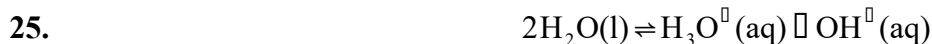
Order of reaction

	F_2	ClO_2
A.	1	1
B.	1	2
C.	2	1
D.	2	4

24.
$$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) \quad \Delta H = -197.8 \text{ kJ}$$

The reaction above is an important step in the production of sulfuric acid. An increase in which of the following will increase the ratio of $\frac{\text{SO}_3(\text{g})}{\text{SO}_2(\text{g})}$ at equilibrium?

- A. Pressure only
- B. Temperature only
- C. Both temperature and pressure
- D. Neither pressure nor temperature



The equilibrium constant for the reaction above is 1.0×10^{-14} at 25°C and 2.1×10^{-14} at 35°C . What can be concluded from this information?

- A. $[\text{H}_3\text{O}^+]$ decreases as the temperature is raised.
- B. $[\text{H}_3\text{O}^+]$ is greater than $[\text{OH}^-]$ at 35°C .
- C. Water is a stronger electrolyte at 25°C .
- D. The ionisation of water is endothermic.

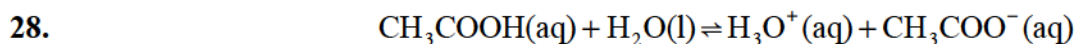


What is the equilibrium expression for the reaction above?

- A. $K_c = \frac{[\text{NH}_3]}{[\text{N}_2][\text{H}_2]}$
- B. $K_c = \frac{2[\text{NH}_3]}{[\text{N}_2][\text{H}_2]}$
- C. $K_c = \frac{2[\text{NH}_3]}{3[\text{N}_2][\text{H}_2]}$
- D. $K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$

27. 10 cm^3 of an HCl solution with a pH value of 2 was mixed with 90 cm^3 of water. What will be the pH of the resulting solution?

- A. 1
- B. 3
- C. 5
- D. 7



In the equilibrium above, what are the two conjugate bases?

- A. CH_3COOH and H_2O
- B. CH_3COO^- and H_3O^+
- C. CH_3COOH and H_3O^+
- D. CH_3COO^- and H_2O

29. Which of the following is the weakest acid in aqueous solution?

- A. $\text{C}_6\text{H}_5\text{OH}$ $K_a = 1.3 \times 10^{-10}$
- B. HCN $K_a = 4.9 \times 10^{-10}$
- C. H_2Se $K_a = 1.5 \times 10^{-4}$
- D. HF $K_a = 6.9 \times 10^{-4}$

30. Which salt will produce the most alkaline solution when dissolved in water?

- A. KNO_3
- B. MgCl_2
- C. $\text{CH}_3\text{CO}_2\text{Na}$
- D. $(\text{NH}_4)_2\text{SO}_4$

31. In the electrolysis of molten sodium chloride, the sodium ion goes to the

- A. positive electrode where it undergoes oxidation.
- B. negative electrode where it undergoes oxidation.
- C. positive electrode where it undergoes reduction.
- D. negative electrode where it undergoes reduction.

32. Which one of the following could reduce $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$ to $\text{Cr}^{3+}(\text{aq})$?

- A. $\text{Ca}^{2+}(\text{aq})$
- B. $\text{Cu}^{2+}(\text{aq})$
- C. $\text{Fe}^{2+}(\text{aq})$
- D. $\text{Zn}^{2+}(\text{aq})$

33.
$$\begin{array}{ll} \text{Tl}^+(\text{aq}) + \text{e}^- \rightarrow \text{Tl}(\text{s}) & E^\circ = -0.336 \text{ V} \\ \text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s}) & E^\circ = 0.339 \text{ V} \end{array}$$

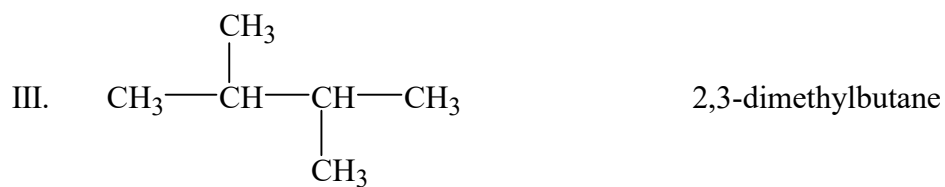
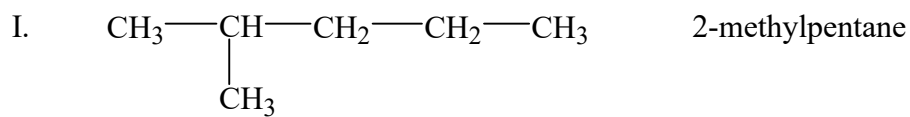
The standard electrode potentials for two metals are given above. What are the equation and cell potential for the spontaneous reaction that occurs?

- A. $\text{Tl}^+(\text{aq}) + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Tl}(\text{s}) + \text{Cu}(\text{s})$ $E^\circ = 0.003 \text{ V}$
- B. $2\text{Tl}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightarrow 2\text{Tl}^+(\text{aq}) + \text{Cu}(\text{s})$ $E^\circ = 0.675 \text{ V}$
- C. $2\text{Tl}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightarrow 2\text{Tl}^+(\text{aq}) + \text{Cu}(\text{s})$ $E^\circ = 1.011 \text{ V}$
- D. $2\text{Tl}^+(\text{aq}) + \text{Cu}(\text{s}) \rightarrow 2\text{Tl}(\text{s}) + \text{Cu}^{2+}(\text{aq})$ $E^\circ = 0.333 \text{ V}$

34. When molten magnesium chloride is electrolysed, how many moles of gaseous chlorine will be produced for every mole of magnesium?

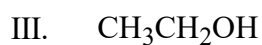
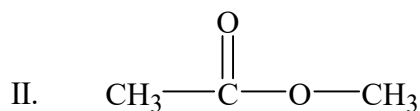
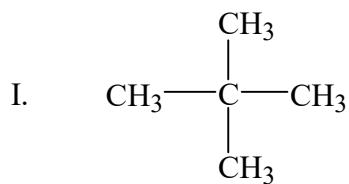
- A. $\frac{1}{2}$
- B. 1
- C. 2
- D. 4

35. Which names are correct for the following isomers of C_6H_{14} ?



- A. I only
- B. I and II only
- C. I and III only
- D. I, II and III

36. Which of the compounds below will show a single peak in its $^1\text{H-NMR}$ spectrum?



- A. I only
- B. III only
- C. I and II only
- D. I, II and III

37. What is the correct order of reaction types in the following sequence?

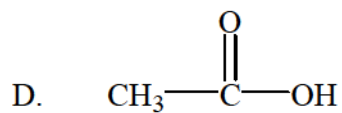
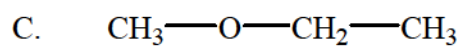
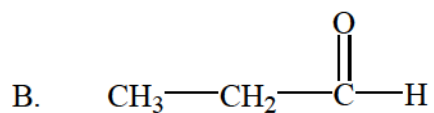
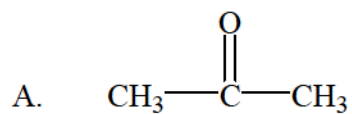


- | | I | II | III |
|----|--------------|--------------|----------------|
| A. | substitution | oxidation | esterification |
| B. | addition | substitution | substitution |
| C. | oxidation | substitution | addition |
| D. | substitution | oxidation | substitution |

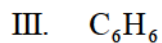
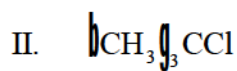
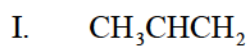
38. Which carbon-containing product is most likely from the reaction of C_2H_4 and Br_2 ?

- A. $\text{C}_2\text{H}_5\text{Br}$
- B. $\text{C}_2\text{H}_4\text{Br}_2$
- C. $\text{C}_2\text{H}_3\text{Br}$
- D. $\text{C}_2\text{H}_2\text{Br}_2$

39. Which of the following is expected to be a gas at 25° C?



40. Which of the compounds below is/are more likely to undergo substitution, rather than addition, reactions?



A. I only

B. II only

C. I and III only

D. II and III only